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BULLETIN 929
APRIL 1959

Oats

for grain...

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winter pasture...

...and other uses

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TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

Summary

Oats are one of the most widely grown crops in Texas. Although they are important as a cash crop only in the concentrated production areas of Central Texas, their indirect contribution to farm income as winter pasture, green-chop feeding, hay or silage often equals their value for grain.

The oats acreage is widely distributed in Texas. The type and varieties grown in an area are determined by winter temperatures, disease resistance and uses made of the crop. Most of the oats are fall sown although in seasons of favorable spring rainfall or when winterkilling occurs, larger acreages are spring sown.

The acreage of oats has expanded in recent years because of increased use of the crop as (a source of) winter pasture and for other forage uses. The crop responds well in increased forage yields to applications of fertilizer. A new use of oats for forage is green-chop feeding of livestock. The crop also may be used for silage and hay and is a high yielding green-manure crop.

Winterkilling is a major hazard of production but the recent development of adapted hardy varieties such as Mustang and Bronco have increased the dependability of fall-sown oats in the northwestern part of the State.

Diseases are important factors in production of oats for both grain and forage in Texas. The major diseases are crown rust, stem rust, Helminthosporium blights and smut. These and other diseases are described and control measures are suggested.

The major insects attacking oats are greenbugs (aphid), spider mites and army or cutworms. Insecticides are now available for control of these insects. Breeding (work) to develop oat varieties resistant to greenbugs is in progress.

Improvement work on oats is in progress. Objectives include improvement of disease resistance, insect resistance, the development of better grain and forage producing varieties for the many producing areas and the development of short, strong-strawed varieties for high fertility conditions.

RECOMMENDED AND ACCEPTABLE OAT VARIETIES BY AREAS

	Fall seeding		Spring seeding	
	Recommended	Acceptable	Recommended	Acceptable
Area 1	Mustang Bronco Wintok Cimarron		Alamo	Mustang New Nortex
Area 2	Mustang Bronco	New Nortex	Alamo	Mustang New Nortex
Area 3	New Nortex Mustang Bronco		Alamo	Mustang New Nortex
Area 4	New Nortex Alamo	Mustang Bronco	Not recommended	
Area 5	Alamo		Not recommended	
Area 6	New Nortex Mustang Bronco		Alamo	Mustang New Nortex
Area 7	Mustang Bronco	New Nortex	Not recommended	

Oats for Grain, Winter Pasture and Other Uses

I. M. ATKINS, J. H. GARDENHIRE and K. B. PORTER*

OATS, ONE OF THE CROPS MOST WIDELY GROWN in Texas, are used extensively for grain, winter pasture, hay, silage and other purposes. While oats are a major cash crop only in the more concentrated areas of production such as North Central Texas, their indirect contribution to farm income through their many uses for forage often equals or exceeds their value for grain. During 1947-56 the seeded acreages of oats averaged 1,740,000 acres, the harvested area was 1,172,000 acres and the average production was 25,473,000 bushels.

The official estimates include only part of the large acreage devoted to forage and other special purposes. The use of oats for all purposes has greatly expanded in recent years, as shown by the official estimate for 1957, 2,670,000 acres. Unofficial estimates made by county agents in 1955 and 1957 indicate that the acreage for forage purposes problably exceeds 1,000,000 acres per year; so the acreage devoted to oats probably exceeds 3,000,000 acres in recent years. Figure 1 shows the distribution of oats for grain in Texas in 1954. Figure 2 shows the unofficial estimated acreage devoted to oats seeded for forage purposes in Texas in 1957.

Adaptation

Oats are grown under a wide range of soil and climatic conditions in Texas. Because of this and their wide range of usefulness, many varieties and types are needed and can be grown. Along the Gulf Coast, spring-type or other varieties with low cold tolerance can be fall sown for livestock pasture. Farther north, in North Central Texas, varieties which can withstand wide fluctuations in winter temperatures are needed. Winterkilling of oats occurs about 1 year in 4 in this area and may range from minor leaf injury to complete destruction of the crop on thousands of acres. An extreme example of such wide temperature fluctuations occurred at Denton, Texas, in February 1943, when the temperature dropped from 83° F. to 5° F. within a period of 48 hours. The survival of oats from fall seeding in the High Plains area where temperatures are more uniformly low usually reflects true cold resistance. Only the most cold-resistant varieties will survive in that area.

*Respectively, agronomist in charge of small grain research, Texas Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, College Station, Texas; agronomist, Substation No. 6, Denton, Texas; and agronomist, Southwestern Great Plains Field Station, Bushland, Texas.

The wide range in climatic conditions may be observed in Table 1. For example, oats may be spring sown at Stratford in Northwest Texas, where the average rainfall for the growing season is 9.9 inches, the mean annual temperature is 55.4° F. and the frost-free period is 177 days; or, by contrast, they may be fall sown at Beaumont, where the average rainfall for the growing season is 39.4 inches, the mean annual temperature is 68.6° F. and the frost-free period is 271 days.

Because of the wide diversity of climate under which the crops are grown and the tests conducted, the State is divided into seven areas, Figure 3. Performance trials are conducted in the different growing areas within the State. Recom-

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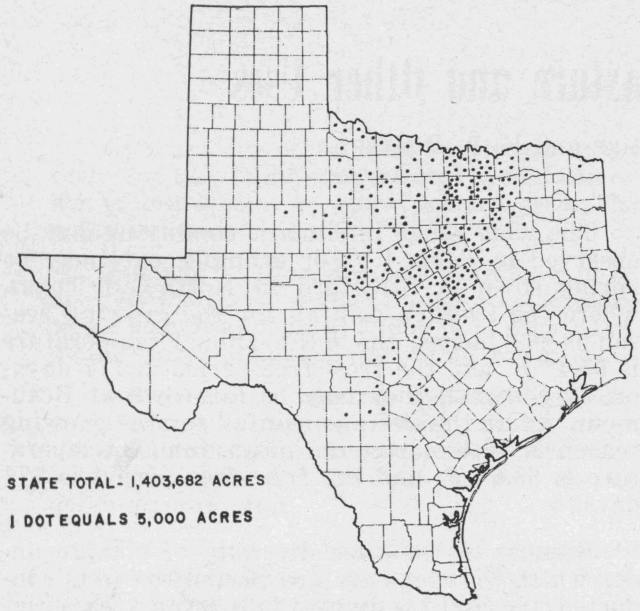

Figure 1. Distribution of oats grown for grain or grain and forage in Texas in 1954.

mendations of varieties and methods of culture also are given by areas.

Uses

Almost all oat grain produced in Texas is utilized as feed for livestock within the State. The vast areas devoted to ranching provide a good market for surplus grain produced in other areas. Oats have long been known as one of the best balanced and desirable feeds for young livestock and breeding herds. Large quantities are used as scratch grain for poultry and still larger quantities go into commercial mixed feeds for all types of livestock.

The high value of oats and other small grains as winter pasture for livestock under the mild

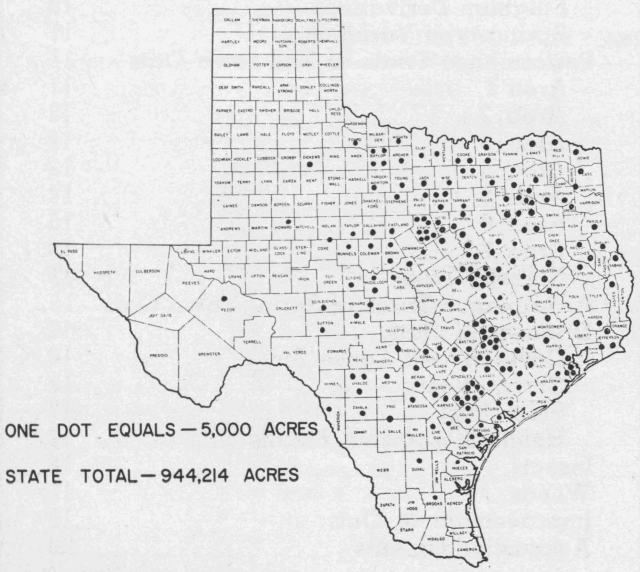

Figure 2. Distribution of oats grown exclusively for forage in Texas in 1957.

winter conditions in much of Texas has been fully recognized only recently. This is evident from the expansion of oat acreage from an average of 1,412,000 acres for 1936-47 to an estimated total of 2,670,000 acres in 1957. There are opportunities for still further expansion of acreages as better adapted varieties are developed. Oats are a favorite crop for winter pasture for livestock of all kinds because they produce a succulent high protein feed during the winter when permanent pastures are dormant.

Recent studies of the value of oats and other small grains for forage purposes have been reported in Texas Agricultural Experiment Station Bulletin 893 "Pasture, Hay and Silage Crops for East Texas" and in progress reports from several substations. These studies show that 4,000 to 6,000 pounds of air-dry forage per acre may be produced under normal rainfall conditions many seasons. Under irrigation and with adequate fertilization, production can be raised to 10,000 pounds per acre.

Experimental tests, as well as experience by growers, have shown that well regulated grazing of oats may furnish an important source of revenue without any reduction in grain yield provided the livestock are removed before the spring elongation of tillers starts. Observations also have shown that properly grazed oats are injured by low temperatures less often than are succulent, rank growing, ungrazed oats.

Varieties differ considerably in their production of forage and the time at which they produce the maximum amount. They likewise differ in response to temperatures; some producing little forage during very cold weather while others continue to grow during both cold and mild weather. Growers should select the varieties adapted to their forage needs. The differences in growth habits of varieties are illustrated in Figure 4.[1] Alamo, an erect-growing type, produces forage more quickly than Mustang in the fall but produces much less than Mustang during the winter and spring at many locations.

Greenchop feeding is a recent development in the use of oats for forage. By this method, oats are allowed to develop sufficient growth to be cut with a field ensilage cutter. The chopped feed is hauled to feedlots for dairy or beef animals. Only enough is cut each day to supply the needs of the livestock for that day. The harvesting proceeds across the field as needed and the harvested portion is allowed to recover and make considerable growth before it is cut again. Often fertilizer is added, or the field may be irrigated, if water is available, to stimulate regrowth. Varieties vary in their recovery from such mechanical clipping. The erect-growing types may be damaged more than the prostrate-growing varieties.

Oats nearing maturity may be used as an ensilage crop alone or in mixtures. Many fields

[1]Taken from data published in TAES Bulletin 893.

yield 6 to 8 tons of silage per acre when harvested in the soft dough stage. Some growers have found it desirable to add dry ear corn, dry hay or stover to oat silage to improve the quality. The early harvested oat silage may be especially advantageous to dairymen because it provides succulent feed during the summer drouth.

Oats alone, or in mixtures with sweetclover or other legumes, make a valuable hay crop. The crop should be cut while the leaves and stems are still green and the grain is in the soft dough stage. Hay made from oats at this stage is much higher in feeding value and more palatable than that cut at more mature stages. Oat straw is more palatable and nutritious than wheat or barley straw.

Oats may be turned under for green manure and this use of the crop is increasing. There are some problems of management when oats are grown during the winter and plowed down before a summer crop such as cotton is planted, but these problems are not insurmountable. Where irrigation water is available, oats will produce considerable green material which decays rather quickly when plowed under. The many fine fibrous roots of the oats give good distribution of this organic matter in the soil and the total tonnage is equal or greater than that of vetch or winter peas, which normally do not make much growth until warm weather. Oats also are valuable as a companion crop for sweetclover and as a cover crop to reduce erosion by wind or water. A good stand of clover in a field of oats is shown in Figure 5.

Culture

The cultural operations for oats are similar to those required for other small grains. The best yields are obtained when well-adapted varieties are sown on fertile, well-drained soil with proper seedbed preparation and with proper fertilization where this is practical.

PLACE IN THE ROTATION

In the principal grain growing areas of Central Texas, oats may follow nearly any crop although the most common sequence is for oats to follow cotton or corn. Cotton is an ideal crop to precede oats as the soil is usually firm, free of weeds and preparation for seeding oats is inexpensive. Corn matures sufficiently early to allow time for good seedbed preparation for fall-sown oats. Grain sorghum land is less desirable for oats because the soil moisture is depleted and decay of the root and other crop residues is slow. The application of nitrogen to assist in the decay of such residues usually is desirable.

The use of oats as a companion crop for sweetclover is a desirable combination in areas

TABLE 1. AVERAGE TEMPERATURE, RAINFALL, LENGTH OF GROWING SEASON AND SOIL TYPE AT TEST LOCATIONS[1]

Area and location	Elevation, feet	Number years of record	Rainfall, inches			Temperature, degrees F.			Length of growing season	Average date		Soil type
			Average		Average 1949-56	Average annual	Average maximum	Average minimum		First killing frost	Last killing frost	
			Annual	Growing season[2]								
Area 1												
Stratford	3699	30	17.5	9.9	14.4	55.4	71.0	40.2	177	Oct. 16	Apr. 22	
Spearman	3100	45	21.3	16.7	19.7	57.0	70.7	42.1	185	Oct. 22	Apr. 20	
Bushland	3590	18	17.7	12.7	17.0	57.7	72.9	42.2	193	Oct. 27	Apr. 16	Pullman silty clay loam
Hereford	3806	26	19.6	14.1	15.5	57.5	72.6	42.4	187	Oct. 22	Apr. 18	
Plainview	3250	30	21.3	12.6	15.8	59.8	73.7	45.7	206	Nov. 2	Apr. 10	
Area 2												
Spur	2274	46	20.4	13.6	18.2	62.2	77.3	47.0	216	Nov. 4	Apr. 3	Abilene clay loam
Chillicothe	1406	51	24.3	17.2	23.5	63.4	76.6	50.3	231	Nov. 10	Mar. 24	Abilene clay loam
Iowa Park	978	31	29.0		28.5	65.0	78.2	51.9	221	Nov. 4	Apr. 1	Miller sandy loam
Abilene	1759	71	22.6	19.4	18.9	64.1	76.1	52.1	241	Nov. 19	Mar. 23	
Area 3												
Stephenville	1283	15	26.9	23.8	25.2	65.2	77.1	53.3	239	Nov. 13	Mar. 21	Denton clay
Greenville	550	36	40.0	32.9	37.3	64.1	75.1	53.2	235	Nov. 11	Mar. 15	Hunt clay
Denton	621	44	32.0	24.6	27.2	65.7	77.3	54.2	233	Nov. 12	Mar. 22	San Saba clay
Area 4												
McGregor	713	34	31.6	25.6	23.3				254	Nov. 24	Mar. 24	San Saba Clay
Temple	675	44	33.7	27.3	27.2	67.4	79.3	55.4	251	Nov. 24	Mar. 18	Houston Black clay
Comfort	1412	71	30.5	26.5	25.6	64.5	78.2	50.7	216	Nov. 1	Mar. 30	
Area 5												
College Station	314	50	38.9	30.0	33.7	68.4	79.5	57.2	263	Nov. 25	Mar. 6	Lufkin fine sandy loam
Lockhart	518	60	31.6	27.9	24.6	68.5	79.1	57.8	268	Dec. 1	Mar. 4	Houston Black clay
Prairie View	251	42	40.5	25.1	32.8	68.0	90.0	45.0	275	Nov. 28	Feb. 18	Hockley fine sandy loam
Beeville	225	53	29.4	22.9	16.7	70.7	82.5	61.2	291	Dec. 6	Feb. 20	Clareville clay
Winter Haven	596	36	23.2			74.0	84.7	63.2	330	Dec. 20	Jan. 25	Willacy sandy loam
Beaumont	18	43	54.2	39.4	49.9	68.6	80.3	57.4	271	Nov. 25	Feb. 27	Beaumont clay

[1]No tests were conducted in areas 6 and 7.
[2]September 1 to June 1.

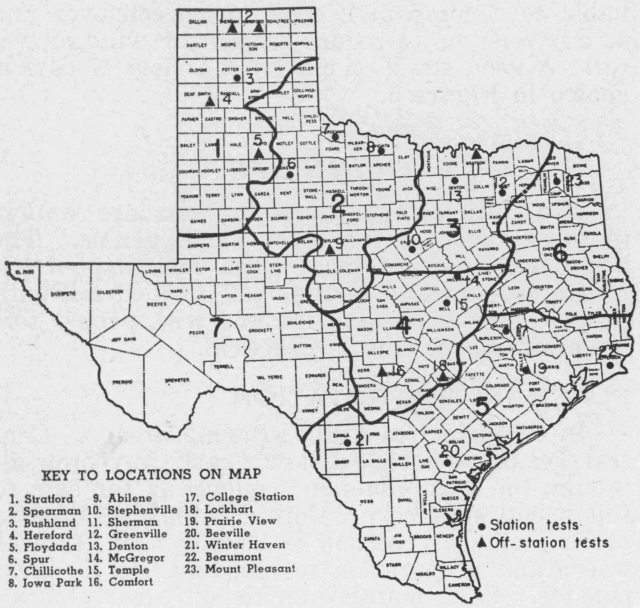

Figure 3. Small grain growing areas and test locations in Texas.

3 and 4. In area 4 and farther south, these crops may both be fall sown, but in area 3 there is some danger of winterkilling of the sweetclover. Clovers may be sown with spring oats in January or February in area 3. Clover must be seeded in a separate operation as it requires shallower seeding than do oats. After the oats are harvested, the clover may produce hay, pasture or a seed crop.

Oats are not grown extensively in area 1 except when spring moisture conditions are favorable for seeding. Fall seeding is hazardous because of low winter temperatures but, when oats do survive the winter, they usually produce better yields and quality of grain than do spring-sown oats.

Oats should not follow oats or other small grains because volunteer grain and wild oats

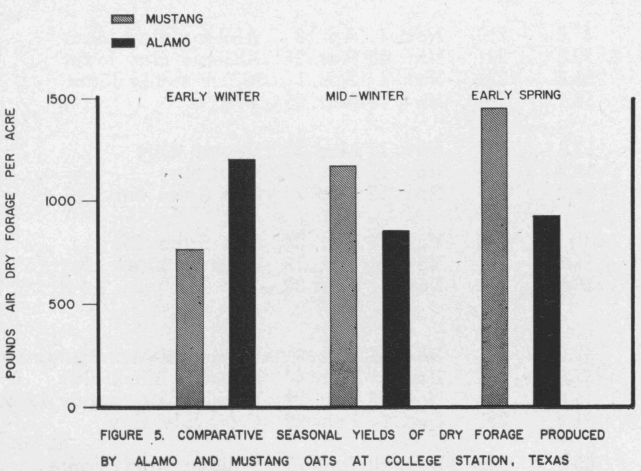

Figure 4. Comparative seasonal yields of dry forage produced by Alamo and Mustang oats at College Station, Texas.

not only cause undesirable mixtures, but these volunteer plants permit early establishment and increase of diseases and insects which immediately attack the seeded crop when it emerges.

SEEDBED PREPARATION

Seedbeds for oats should be firm and level to permit uniform seeding. When oats follow cotton, the stalks should be shredded and the land leveled with a disk harrow and a drag or spike tooth harrow. Corn or sorghum land usually is plowed after shredding the stalks, but the land should be worked down immediately to cover crop residues and hasten decay. An application of nitrogen at this time will hasten decay of residues.

Because of the danger of soil blowing, seedbeds intended for spring-sown oats in area 1 should be left rough through the winter to retain moisture received as snow. Seedbeds for fall-sown oats in this area should be prepared as carefully as those for wheat.

RATE AND DATE OF SEEDING

Dates of seeding vary greatly in the State because of the wide range in climatic conditions and uses of oats. The dairyman or other livestock producer may find it practical to seed at the earliest opportunity in the fall or, if he has irrigation water available, to irrigate and then sow the crop very early for grazing purposes. The grain producer who does not pasture the crop should not seed early because the soil moisture may be dissipated or the plants become so rank that they may be easily injured by low temperatures. Very late fall seeding may result in greater damage from low temperature, especially if the crop is not well established. Table 2 gives suggested data and rates of seeding.

Rate of seeding is relatively unimportant in fall-sown oats because the plants have several months in which to tiller and adjust to environmental conditions. Rates for spring seeding are commonly higher than those for fall seeding. Under irrigation, where late seeding is necessary or when maximum early forage is needed for livestock, rates should be increased. Contrary to common opinion, thicker seeding is desirable in low fertility soil because the plants tiller less.

Yields of forage when the oats were seeded at four rates at Winter Haven and at Kirbyville, are shown in Table 3. Grain yields of three varieties of oats seeded in January at five rates at Denton, 1953-55 are shown in Table 4.

HARVESTING AND THRESHING

Until fairly recently, the most common method of harvesting oats in Texas was with the grain binder, followed by private or custom threshing from the shock. The oat straw in stacks was of considerable value to the livestock producer as a source of winter roughage. A small acreage still is handled in this manner.

TABLE 2. SUGGESTED DATES AND RATES FOR SEEDING OATS IN AREAS SHOWN

Area	Suggested seeding date		Suggested seeding rates per acre, pounds	
	Fall	Spring	Fall	Spring
1	Sept. 15	March 1	48	56
2	Oct. 1	Feb. 15	64	72
3	Oct. 15	Jan. 15	72	96
4	Oct. 15	Jan. 1	72	96
5	Nov. 1	[1]	72	[1]
6	Oct. 15	[1]	72	[1]
7	Nov. 1	[1]	72	[1]

[1]Not recommended.

The recent scarcity of farm labor, combined with the need for greatest economy in the harvesting operation, has forced growers to use some form of combine harvesting. Direct combine harvesting of oats, even when the straw has broken down, is common and, with modern equipment, is fairly satisfactory. The straw of oats is weaker than that of other small grains and many varieties break over almost as soon as they mature. The Red Rustproof strains are very weak straw-ed, whereas Alamo, Fultex, Victorgrain and several others have much stronger straw.

Under many conditions it is more desirable to place the crop in the windrow and thresh a few days later with a combine equipped with a pickup attachment. This method is especially desirable when the crop is excessively tall and is in danger of severe lodging, when green weeds are abundant in the field or where moisture conditions are unfavorable for drying of the crop on the standing grain.

When harvesting with the combine, care should be taken that the grain is fully mature and contains not more than 13 percent moisture. Higher moisture content may cause heating in storage with damage to germination and feeding quality. Insects increase much more rapidly in grain of high moisture content. Farm and commercial grain drying equipment are rapidly becoming available in the State for rice, grain sorghum and other crops. The grower should make certain excessively high temperatures are not used for drying oats to be used for seed. Temperatures above 105° F. may seriously damage germination of the grain. Windrowing of oats is shown in Figure 6 while threshing of the grain from the windrow with a combine having a pick-up attachment is shown in Figure 7.

TABLE 3. EFFECT OF SEEDING RATE ON AIR-DRY FORAGE PRODUCTION OF OATS AT WINTER HAVEN AND KIRBYVILLE

Location, period and rate of seeding	Average yield of forage, pounds per acre			
	Early winter	Mid-winter	Early spring	Total
Winter Haven, 1952-53[1]				
1.5 bushels	3110	2380	4050	9540
2.0 bushels	3060	2790	3480	9330
2.5 bushels	3380	1740	3480	8600
3.0 bushels	4400	2010	3680	10090
Kirbyville, 1953-54[2]				
1.5 bushels	1020	1440	2520	4980
2.0 bushels	1090	1610	2440	5140
2.5 bushels	910	1630	2650	5190
3.0 bushels	1090	1750	2520	5360

[1]Under irrigation.
[2]Without irrigation.

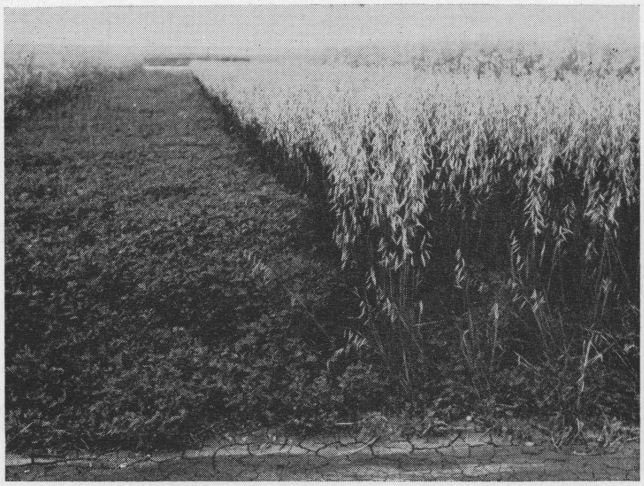

Figure 5. A good stand of sweetclover in oats growing at Denton, 1951.

FERTILIZERS

Oats respond with increased grain and forage yields to the application of commercial fertilizers or barnyard manure. Excessive amounts of nitrogen may increase lodging under some conditions. Fertilizer recommendations for Texas are available in Texas Agricultural Extension Service Leaflets L-220 through L-228.

WINTERKILLING

The loss or reduction of stands and killing of top growth are important factors in oat production in Texas. Low temperatures make fall seeding of oats hazardous in area 1. Winterkilling occurs on an average of 1 year out of 4 in areas 2 and 3 and less often in area 4. The use of new winter-hardy varieties combined with better cultural practices has reduced this damage in recent years but cold injury continues as a potential threat. The fall-seeded crop that is well established and growing in fertile soil is less frequently damaged by low temperatures than one poorly established. Adequate available phosphorus will aid in reducing winterkilling, as shown in Figure 8 at Temple, 1948, where stands in the unferti-

TABLE 4. COMPARATIVE AVERAGE YIELDS OF THREE VARIETIES OF SPRING-SOWN OATS AT FIVE RATES OF SEEDING AT DENTON, 1953-55

Rate of seeding	Average yield of grain, bushels per acre		
	Alamo	New Nortex	Mustang
2.0	49.1	33.5	43.8
2.5	50.1	34.6	45.1
3.0	48.0	33.4	42.2
3.5	47.5	33.4	41.4
4.0	47.6	34.6	42.2

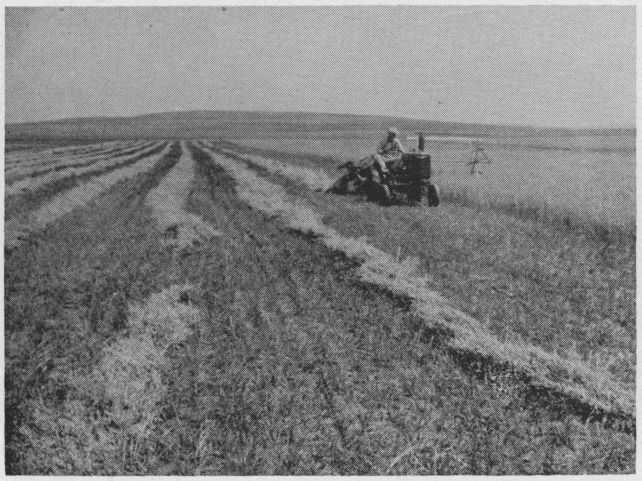

Figure 6. Windrowing oats at the Denton station, 1952.

lized portion of the field were reduced by low temperatures.

Varieties vary greatly in cold tolerance. Spring-type varieties from the main oat growing sections of the Midwest have little cold resistance and should not be fall sown. The greatest cold resistance is found in such varieties as Wintok, Bronco, Mustang, Cimarron and Fulwin. A second group that in hardiness tests ranges from 15 to 20 percent less hardy includes the Red Rustproof strains, Fultex, Victorgrain, DeSoto and Suregrain. A third still less hardy group used for fall seeding only in South Texas includes Alamo, Camellia, Alber, Ranger and Fulgrain. The cold resistance of Bronco and Mustang in comparison with New Nortex is shown in Figure 9. Bronco oats yielded 51.4 bushels per acre at Iowa Park in 1951 because of their cold resistance, while New Nortex averaged only 3 bushels.

Varieties

Several varieties and types of oats may be grown successfully in Texas because of the wide range in growing conditions. Until recently the

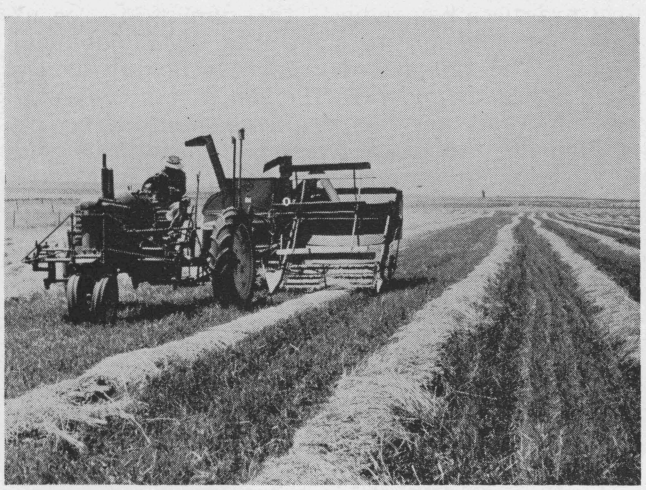

Figure 7. Threshing oats from the windrow with a combine with pickup attachment, Denton, 1951.

Red Rustproof (*Avena byzantina*) type oats have dominated the acreage in Texas and the South ever since their introduction before 1850. While less hardy than some varieties and less resistant to some diseases than certain new varieties, they have wide adaptation for both fall and spring seeding because of their tolerance to many hazards. Therefore, they have continued to find favor with growers. Early oat selection work in Texas was carried on at Substation No. 6, Denton, Texas, and by the Ferguson Seed Farms, Howe, Texas, which is no longer in business. This firm distributed Ferguson 71 oats in 1916 and Ferguson 922 in 1926. The Texas Agricultural Experiment Station distributed Nortex oats in 1926 and New Nortex in 1936.

Brief descriptions of varieties grown in the State or available commercially are given in this section. For convenience the varieties are grouped in part by hardiness classes and in part by parental relationships or morphological similarities.

WINTER HARDY VARIETIES

During the past 10 years a number of new varieties that possess considerably more winter hardiness than the Red Rustproof strains have become available. These extended northward the fall-sown oat growing area of the United States and reduced the hazards of winterkilling. Two of these varieties, Bronco and Mustang, were developed in Texas and have made important contributions to oat production in Texas and elsewhere.

Mustang (Lee-Victoria x Fulwin) was distributed by the Texas Agricultural Experiment Station in 1948. It has outstanding ability to withstand wide fluctuations in temperature and, under Texas conditions, has been nearly as winter hardy as Fulwin or Wintok (see Tables 5, 6 and 7). Seedlings are prostrate with narrow leaves when grown in Northwest Texas, but when the variety is grown for winter pasture in South Texas it responds to warmer temperatures and is very desirable for this purpose. Mustang matures 5 to 8 days earlier than New Nortex. It has short straw of good strength, but the grain may shatter under some conditions. The variety is resistant to some races of crown rust and tolerant to Helminthosporium blight under many conditions. It is susceptible to stem rust. The seed are grey and fairly small but of good test weight. Mustang has excellent resistance to drouth and has extended greatly the usefulness and increased the safety of growing oats in the western part of the state.

Bronco (Lee-Victoria x Fulwin) is a sister selection of Mustang. It differs in being taller, later maturing and the grain is light red. The variety has the capacity for very high yields under favorable conditions. Seedlings are prostrate and the leaves are narrow. Bronco makes slow growth in the fall and winter and because of this characteristic has not found favor as for-

age. The variety was distributed by the Texas Agricultural Experiment Station in 1956 but has been recommended recently also in Kentucky and Virginia.

Fulwin, Tennex and *Forkedeer* are winter hardy varieties that were selected from a hardy, winter-type strain of Fulghum. The Tennessee Agricultural Experiment Station developed and distributed all three. Fulwin and Tennex are grown on a small acreage in Texas. Fulwin is one parent of Mustang and Bronco. All three varieties are very susceptible to the rusts and therefore poorly adapted in most parts of Texas.

Wintok (Hairy Culberson and Winter Fulghum, C. I. 2498) is the most winter hardy oat variety grown commercially in the United States. It was distributed by the Oklahoma Agricultural Experiment Station in 1946. Seedling growth is prostrate with the leaves narrow and dark green. The plants are of moderate height but the straw is weak. The grain is grey, of moderate size and of good test weight. The variety is very susceptible to the rusts and therefore adapted only in Northwest Texas.

Cimarron is an early maturing, cold resistant variety recently distributed by the Oklahoma Agricultural Experiment Station. The variety is especially suited to both fall and spring seeding in Oklahoma. It is very susceptible to the rusts and adapted only in Northwest Texas. In addition it sometimes develops a physiologic leaf firing that destroys much tissue and may affect yields.

Arkwin (Tennessee 1922 x Bond-Iogold) was distributed by the Arkansas Agricultural Experiment Station as a forage oat for Arkansas. It is winter hardy and an early forage producer. The variety is tall, has strong straw and the grain is light red. Arkwin has produced lower yields of grain than many varieties and is not recommended in Texas.

RED RUSTPROOF STRAINS AND DERIVATIVES

The original Red Rustproof oats were brought to this country from the Mediterranean region of Europe before 1850. They quickly spread across the southern United States and were given local names in many instances by growers, seedsmen or state agencies. Thus they became known as Texas Red Rustproof, Appler Rustproof, Bancroft Rustproof, California Red Oats and such. Most of the strains are similar, differing only in minor characteristics.

New Nortex is perhaps the most widely grown strain of Red Rustproof. A survey in 1957 showed that it is grown on 29 percent of the Texas acreage and is grown in several other southern states. New Nortex is a typical Red Rustproof. Seedling plants are prostrate growing and tiller abundantly. New Nortex has unusual ability to remain dormant during periods of drouth in winter or early spring and then respond rapidly when rains come. The variety is moderately winter hardy but may be winterkilled in areas 2 and 3 and is not sufficiently hardy for fall seeding in area 1. The plants are of medium height and the straw is rather weak. The panicles are medium large to large and the kernels are large, long and red. On a typical spikelet, both kernels usually have awns but there are many exceptions depending on environment. All the Red Rustproof strains grown in Texas are susceptible to leaf and stem rust but they seem to be rather tolerant because their yields usually are reduced less by rust than other varieties. All strains also are resistant or tolerant to attacks by most species of Helminthosporium and several other diseases.

Figure 8. Oats fertilized at seeding time with phosphorus survived low temperatures when stands in the unfertilized portion of the field (left) were greatly reduced, Temple, 1948.

Several other strains of Red Rustproof are grown in Texas. *Nortex,* the original strain distributed by the Denton station, is similar to New Nortex. Under some conditions it may be shorter and slightly earlier. *Ferguson 922* is similar to New Nortex in all visible characteristics. *Nortex 107* was introduced from Mississippi and also

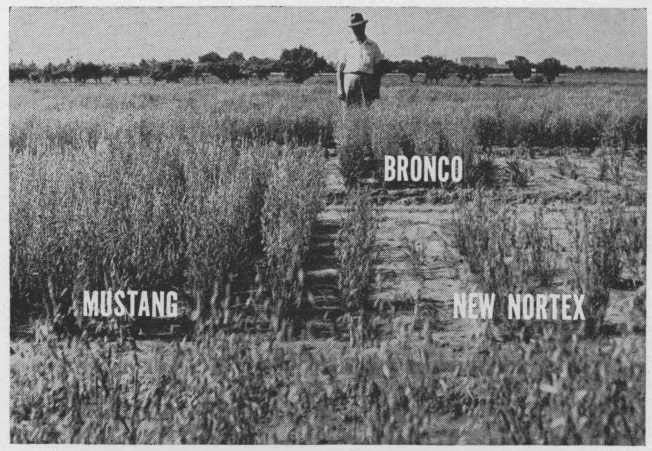

Figure 9. Mustang and Bronco oats survived with good stands at Iowa Park, Texas, in 1951 whereas New Nortex and most other varieties were winterkilled.

is similar to these strains. *Ferguson 560* is a purified seed lot made from Ferguson 922 by the Arkansas Experiment Station to provide a supply of pure seed of this older strain.

Ranger (Nortex x Victoria) and *Rustler*, a sister strain, were distributed by the Texas Agricultural Experiment Station in 1942 and for a few years were grown extensively in South Texas. Both are susceptible to Helminthosporium blight, stem rust and to race 216 of crown rust. Ranger and Rustler are fairly typical Red Rustproof types in most respects but they are less winter hardy than New Nortex. The acreage of these varieties has declined recently.

Alber was introduced from South America by the U. S. Department of Agriculture and later distributed in Louisiana. It is a selection from Red Algerian, a South African oat similar in many respects to Red Rustproof. Alber is taller and later maturing than Red Rustproof and has greater resistance and tolerance to many races of leaf rust. It is also resistant to Helminthosporium blight. It lacks cold resistance so it is adapted only to South Texas.

FULGHUM DERIVATIVES

The original Fulghum oat was selected from Red Rustproof by a Georgia farmer before 1900. It differs from Red Rustproof in being about 2 weeks earlier in maturity and in having grain of higher test weight and with fewer awns. Many selections were made from the original variety and given names such as Early Red Rustproof, Cokers Fulghum, Nicholsons Extra Early and Kanota. A strain selected at the Denton station was distributed as Frazier oats. It was grown extensively for many years but is now grown on only a small acreage. Frazier and Fulghum were used extensively in oat crosses made in Texas and in other states. Frazier has been kept in all Texas yield trials as an historic type and a measure of progress.

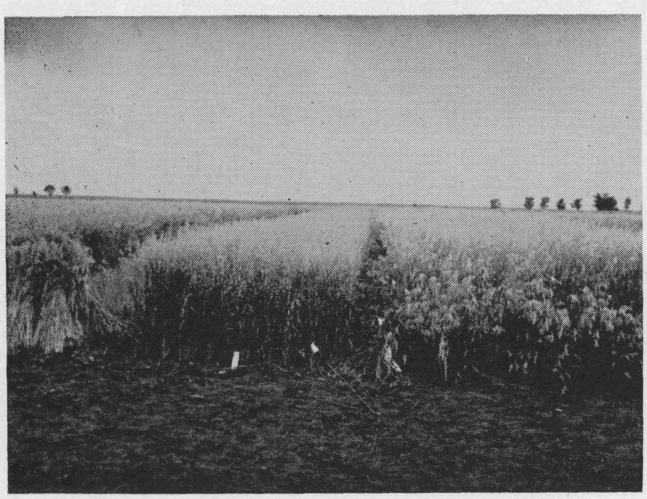

Figure 10. Field plots of oat varieties at Denton, 1953. Left to right, Frazier (Fulghum type), Alamo and New Nortex. Note strong erect straw of Alamo.

Fultex was developed from the cross, Fulghum x Victoria. The variety is early maturing, has short, strong straw making it suitable for combine harvesting and has plump, red kernels of high test weight. It is resistant to many races of crown rust but is susceptible to race 216. Fultex is highly susceptible to Helminthosporium blight.

Alamo resulted from a cross involving five parents, (Fulghum-Victoria) x (Victoria-Hajira-Banner). It was distributed as a rust resistant oat for fall seeding in South Texas and for spring seeding throughout the northern and western parts of the State. Alamo has erect, broad-leaved seedling plants and is less winter hardy than Red Rustproof. The variety is early maturing and produces abundant early grazing when sown for winter pasture, Figure 4. Because of this erect habit of growth, it may be damaged by grazing under some conditions. It has strong straw and will stand erect for combine harvesting better than any variety available in the State. The grains are medium large and plump and the kernels have few or no awns. Alamo was resistant to all the prevalent races of crown and stem rusts until 1957. It is not resistant to race 216 of crown rust or to race 7A of stem rust. It is susceptible to Helminthosporium blight. Alamo is compared with Frazier and New Nortex in Figure 10.

Victorgrain was distributed by the Coker's Seed Company of Hartsville, South Carolina. Several strains of Victorgrain have been distributed, the latest being strain 48-93. The original strains came from the cross Victoria x Fulgrain, but subsequent strains involved other parents as well. This is a semiwinter type oat with moderate hardiness. It was resistant to the races of crown rust prevalent in Texas before 1957 but is susceptible to race 216. It is also susceptible to stem rust and Helminthosporium blight. Seedling growth is moderately upright but the variety is well suited to use as a winter pasture crop. Plants are mid-tall with strong straw. The grain is light red with few or no awns and is of high test weight.

Midsouth was selected from Victorgrain because of its resistance to Helminthosporium blight. Plant characteristics are similar to Victorgrain 48-93 except for small differences in growth habit. It was recently distributed by the Mississippi Agricultural Experiment Station.

Fulgrain was developed by Coker's Seed Company from a cross of Fulghum Strain 4 x Victoria. It is similar to Victorgrain in many respects but is much earlier maturing, less cold tolerant and is damaged by late spring freezes rather frequently. The grain is red, of high test weight and the grain has few awns. It is grown only in the Edwards Plateau area of South Texas.

Delair and *Taggart* were developed from a cross of Fulghum x Bond and distributed in Arkansas and Mississipi. They are semiwinter

type strains which produce upright seedling growth and are lacking in winter hardiness. They have strong straw and plump grain of high test weight. They are susceptible to leaf and stem rusts but resistant to Helminthosporium blight.

Suregrain, (Arlington-Delair) x Trispernia, is a new variety released by Coker's Seed Company in 1958. While only remotely related to Fulghum, it is similar in many characteristics. Suregrain has short, strong straw, plump red grain and resistance to prevalent races of crown rust, including race 216. It is resistant to Helminthosporium blight but susceptible to stem rust. While it appears promising on the basis of preliminary yield trials, it has not been adequately tested and therefore cannot yet be recommended.

Moregrain, [(Arlington-Delair) x Trispernia] x [(Bond-Fulghum) x Victorgrain], is another new variety released by Coker's Seed Company in 1958. Under Texas conditions it is taller, but earlier than Suregrain, has resistance to prevalent races of crown rust and is resistant to Helminthosporium blight. It is susceptible to stem rust. Preliminary yield trials indicate this variety may be valuable in South Texas, but it has not been adequately tested.

Camellia (Bond x Alber) was developed in Louisiana and distributed in 1942. The variety produces vigorous, upright seedlings and is a favorite for winter pasture along the Gulf Coast. It does not have sufficient cold resistance to grow in other areas. Camellia is tall, has large strong straw with large panicles and large red-yellow grains with few awns. Camellia is resistant to many races of crown rust but is susceptible to race 216 and to stem rust. It is resistant to Helminthosporium blight.

SPRING-TYPE VARIETIES

The common white or yellow-seeded oats, *Avena sativa,* with a spring growth habit that are grown in the Corn Belt are not sufficiently cold resistant to be fall sown in most parts of Texas. Occasionally they are used in South Texas for livestock pasture but, owing to their upright growth habit, they are damaged easily by livestock or when cut for green-chop feeding. Data from spring seeding at Amarillo and Denton (Tables 12 and 13) show that these varieties are less productive than Alamo even when spring seeded so none is recommended in Texas.

Performance Trials of Fall-sown Oats

Intrastate yield trials of small grain are conducted at many locations in the State as part of the small grain improvement program. Because of the wide range in climatic conditions, the State is divided into seven testing areas as shown in Figure 3. Varieties and experimental strains are tested by groups for these several areas.

Comparable yield and agronomic data are summarized by areas. All varieties were not grown at all stations in all seasons. In order to compare all varieties, a comparable figure was calculated for each variety based on a standard group of varieties that were grown at all stations in all years. By means of a correction factor suggested by Patterson[2] data on varieties grown for a shorter period were adjusted so all varieties might be compared directly. More detailed data appear in Texas Agricultural Experiment Station Bulletin 899, "Performance of Small Grain Varieties in Texas, 1949-57."

AREA 1

Usually only about 2 percent of the State acreage of oats is grown in this area. Fall seeding is hazardous although the acreage of oats is increasing because of the ample seed supplies of such hardy varieties as Wintok, Mustang and Bronco and the use of irrigation water to provide moisture for germination at the proper time. Particularly in the southern part of this area, the value of oats for fall and early winter grazing for livestock may make them profitable despite the risk of winterkilling. Tests conducted on land receiving supplemental irrigation at Amarillo and Floydada are summarized in Table 5.

Mustang produced the highest comparable grain yield in this area. Frazier ranked second in spite of rather low winter survival some years

[2]Patterson, R. E. A method of adjustment for calculating comparable yields in variety tests. Agronomy Journal 42:509-511, 1950.

TABLE 5. COMPARABLE YIELDS AND AGRONOMIC DATA FOR FALL-SOWN OATS GROWN AT STATIONS IN AREA 1, 1949-57

Variety	Average yield of grain, bushels	Number of tests	Test weight, pounds	Date first head	Date full ripe	Plant height, inches	Winter survival, percent
Mustang	40.8	11	31.3	5-15	6-23	23.6	87
Frazier	38.9	11	33.0	5-10	6-21	23.0	55
Wintok	38.2	11	34.1	5-12	6-21	25.0	93
Cimarron	37.8	7	34.5	5-7	6-18	21.6	86
Fultex	37.6	11	32.1	5-13	6-21	20.4	68
Bronco	35.0	11	31.4	5-21	6-25	27.0	99
New Nortex	34.0	11	32.2	5-11	6-21	23.8	53
Ferguson 922	32.2	3	32.8	5-16	6-21	26.8	58
Fulwin	30.6	11	32.1	5-15	6-22	28.6	92
Alamo	29.7	10	32.4	5-17	6-23	24.7	59

Figure 11. Grazing oats to maturity, a common practice in the ranching areas of Texas.

and Wintok ranked third. Bronco, Wintok, Fulwin, Mustang and Cimarron were the most hardy. The survival of Alamo, New Nortex and Frazier was much lower than the more hardy varieties and therefore these are not so well suited to fall seeding.

Cimarron, Wintok and Frazier had higher test weights than the other varieties. Cimarron and Frazier were the earliest varieties and Bronco the latest. Fultex and Cimarron were the shortest varieties and Bronco the tallest. The varieties Mustang, Wintok, Cimarron or Bronco should be sown in this area if fall seeding is practiced.

AREA 2

Oats are grown extensively in area 2, both as a cash crop and as a combination winter pasture and grain crop. Considerable acreages are used primarily for winter pasture and, unless conditions are very favorable for grain production in the spring, the crop is pastured to maturity at which time the livestock usually can be placed on permanent grass ranges. Cattle pasturing oats late in May as the crop matures are shown in Figure 11.

Yield trials were conducted under irrigation at Iowa Park and under natural rainfall conditions at Chillicothe, Spur and Abilene, although data from Abilene are limited. Severe drouth prevailed throughout this testing period, so yields are probably below what may be expected in this area. Irrigated and dryland yield tests are reported separately, but agronomic data are from all tests. Data on yields and agronomic data are given in Table 6.

Mustang, New Nortex and Bronco produced the highest comparable yields in the irrigated tests at Iowa Park. In dryland tests, Alamo ranked first in average yield as a result of its high yield in 1957, a year when most other varieties were damaged by diseases. This variety is tender and may be winterkilled when fall sown in this area. Survival data, based on years in which winterkilling occurred, show that Alamo survived only 38 percent compared with 74 for Bronco.

Wintok, Victorgrain, Alamo and Frazier produced grain averaging higher in test weight than the Red Rustproof strains. Frazier and Cimarron are the earliest varieties and Bronco the latest.

Varieties recommended for fall seeding in this area are Mustang and Bronco. The Red Rustproof strains also are satisfactory but may be winterkilled in some seasons.

AREA 3

Oats are grown extensively in area 3 both as a cash crop and for winter pasture for livestock. More than one-third of the State acreage is grown in this area. When oats are pastured the livestock usually are removed in late February so the crop will mature a crop of grain. The yield of grain is not reduced when oats are grazed properly.

Winterkilling is a major hazard in this area because winter temperatures fluctuate so widely.

TABLE 6. COMPARABLE YIELDS AND AGRONOMIC DATA FOR FALL-SOWN OATS GROWN AT STATIONS IN AREA 2, 1949-57

Variety	Yield of grain, bushels		Number of tests	Test weight, pounds	Date first head	Date full ripe	Plant height, inches	Estimate of forage value[2]	Winter survival, percent
	Iowa Park 1949-57[1]	Average for area							
Alamo	67.6	31.4	13	32.4	4-15	5-23	22.3	108	38
Bronco	74.8	31.3	15	31.3	4-24	5-30	27.0	98	74
Victorgrain	79.8	31.0	5	32.6	4-13	5-21	24.7	109	—
Mustang	78.7	30.9	18	31.0	4-18	5-25	23.8	103	71
New Nortex	76.1	30.8	18	30.1	4-17	5-24	23.0	100	53
Fultex	67.6	28.1	18	31.7	4-15	5-21	20.6	100	44
Fulwin	65.9	27.7	18	31.4	4-20	5-27	29.2	107	80
Ferguson 922	71.8	27.1	9	29.1	4-17	5-23	22.4	100	49
Nortex 107	82.2	26.7	5	28.9	4-19	5-27	20.3	104	51
Wintok	37.0	26.2	17	32.9	4-18	5-22	23.9	107	68
Cimarron	71.8	26.0	9	31.9	4-9	5-17	22.2	106	75
Frazier	63.1	23.5	18	32.4	4-9	5-19	24.9	112	43

[1]Irrigated tests not included in averages.
[2]Visual estimate of forage value, New Nortex 100 percent.

TABLE 7. COMPARABLE YIELDS AND AGRONOMIC DATA FOR FALL-SOWN OATS TESTED IN AREA 3, 1949-57

Variety	Average yield of grain, bushels	Number of tests	Test weight, pounds	Date first head	Date full ripe	Percent		Plant height, inches	Winter survival, percent
						Crown rust	Stem rust		
Mustang	58.3	23	30.3	4-17	5-23	4	8	25.6	96
Nortex 107	56.6	9	29.5	4-23	5-27	12	7	27.4	82
New Nortex	55.3	23	29.5	4-23	5-27	9	11	27.3	81
Victorgrain	52.8	14	31.8	4-18	5-21	18	13	24.4	76
Bronco	51.6	18	30.2	4-24	5-26	11	8	28.0	93
Ferguson 922	51.0	15	29.1	4-24	5-28	8	7	27.0	73
Alamo	48.2	17	31.5	4-18	5-24	16	1	24.3	46
Cimarron	44.4	9	30.5	4-16	5-20	—	1	24.6	—
Fulwin	43.7	23	29.2	4-22	5-23	71	9	29.4	100
Fultex	42.2	15	31.3	4-17	5-20	13	11	22.7	70
Frazier	40.1	23	31.5	4-13	5-20	37	8	25.2	71

Periods of relatively warm weather with daytime temperatures ranging from 70° to 80° F. may occur at any time during the winter months. These may be followed by drops of 50 to 60 degrees in just a few hours. While minimum temperatures seldom fall below 10° F. and the record low temperature at Denton is −3° F., the rapid changes make it difficult for oats to survive. Such freezes may provide the opportunity for the plant breeder to select hardy strains for increase.

Yield trials were conducted at Denton, Greenville and Stephenville in all years; so 33 comparisons are available for varieties grown the full period. Yield and agronomic data are given in Table 7.

Mustang, Nortex 107 and New Nortex rank first, second and third, respectively, in average yield for area 3. Bronco and Alamo produced somewhat lower yields. The lower yield of Alamo largely is due to winter injury in certain seasons. Mustang and Bronco are the most winter hardy and therefore the safest for fall seeding. New Nortex and other Red Rustproof strains are 15 to 20 percent less hardy and may be winterkilled in some seasons.

Victorgrain, Alamo and Frazier produced grain having the highest test weight and also were among the earliest in maturity. Bronco and the Red Rustproof strains are the latest maturing. Fulwin and Bronco were the tallest varieties and Fultex the shortest. Although no data on lodging are available, Alamo has consistently shown the best straw strength and adaptation to combine harvesting.

Varieties recommended for area 3 are New Nortex, Mustang and Bronco. Fall seeding of Alamo is somewhat risky. Information on several additional commercial varieties is presented in the nursery section and in Table 10.

AREA 4

Approximately one-third of the State oat acreage is sown in area 4. Most of this acreage is sown as a combination grain and winter pasture crop. Considerable acreages are sown exclusively for winter pasture. Performance trials were conducted at Temple, McGregor and Comfort in this area. Yield and agronomic data are given in Table 8.

New Nortex, Alamo, Bronco and Ferguson 922 rank first to fourth, respectively, in comparable yields for this area. These, together with Mustang, also are the major commercial varieties in this area. Winterkilling is usually not a major hazard in this area although it does occur, and this is considered about the nothern limit for safe fall seeding of Alamo, Ranger, Alber or Camellia.

Diseases are major hazards of production in area 4 and this may be partly responsible for the

TABLE 8. COMPARABLE YIELDS AND AGRONOMIC DATA FOR FALL-SOWN OATS GROWN AT STATIONS IN AREA 4, 1949-57

Variety	Average yield of grain, bushels	Number of tests	Test weight pounds	Date first head	Date full ripe	Percent		Plant height inches	Estimate of forage value[1]
						Crown rust	Stem rust		
New Nortex	52.1	20	26.7	4-20	5-22	25	21	28.7	100
Alamo	52.1	17	31.6	4-12	5-21	9	Tr	29.7	138
Ferguson 922	51.6	7	26.1	4-22	5-23	21	25	29.2	105
Bronco	51.3	16	29.7	4-22	5-26	5	34	31.4	94
Camellia	51.2	5	27.7	4-22	5-23	14	32	31.4	95
Mustang	50.5	20	29.4	4-16	5-19	6	21	29.3	102
Nortex 107	49.9	6	27.5	4-21	5-23	26	19	28.0	104
Victorgrain	48.9	15	31.7	4-12	5-18	8	16	29.4	120
Ranger	48.5	20	28.7	4-19	5-22	6	34	29.5	98
Fulgrain	48.3	13	32.5	4-9	5-13	6	16	26.8	134
Alber	47.6	19	27.4	4-15	5-23	9	32	31.7	123
Frazier	44.2	20	31.1	4-4	5-10	45	13	31.1	131
Fulwin	33.3	16	25.7	4-21	5-21	53	21	33.2	94

[1]Visual estimate of forage value, New Nortex 100 percent.

TABLE 9. COMPARABLE YIELDS AND AGRONOMIC DATA FOR FALL-SOWN OATS GROWN AT STATIONS IN AREA 5, 1950-57

Variety	Average yield of grain, bushels	Number of tests	Test weight pounds	Date first head	Date full ripe	Percent		Plant height inches	Estimate of forage value[1]
						Crown rust	Stem rust		
Alamo	52.1	17	35.3	3-24	4-26	11	1	30.9	111
Mustang	49.4	11	31.9	4-1	5-3	12	22	31.6	99
Victorgrain	49.1	17	33.2	3-27	5-1	10	36	33.2	103
Fulgrain	49.3	15	35.5	3-20	4-20	6	28	31.4	121
Alber	47.6	17	29.0	3-26	4-30	4	27	32.7	115
Ranger	45.5	9	30.7	4-2	5-3	5	29	32.7	100
Floriland	45.0	12	32.8	3-18	4-22	2	46	35.6	108
Bronco	44.6	17	29.2	4-11	5-4	19	22	32.2	87
New Nortex	44.0	17	29.5	4-4	5-4	25	27	30.1	96
Camellia	41.2	17	29.8	4-2	5-4	12	28	33.7	104
Seminole	39.8	17	31.8	3-13	4-19	11	34	33.5	109
Frazier	39.6	7	33.5	3-16	4-18	53	24	32.1	106
Fultex	38.2	9	33.5	3-23	4-24	3	24	30.7	105
Sunland	37.5	7	32.1	3-16	4-22	9	31	34.1	108
Southland	37.4	6	31.9	3-25	4-23	13	34	33.5	110

[1]Visual estimate of forage value, Ranger 100 percent.

high ranking of Alamo. This variety showed the greatest resistance to the rusts of the varieties included in these test. Value for winter grazing also is an important consideration in this area. Alamo, Fulgrain, Alber, Frazier and Victorgrain were superior to the New Nortex check while Bronco and Fulwin were valued below it. Fulgrain, Victorgrain and Alamo had the highest test weight grain and were among the earliest in maturity.

Varieties recommended for fall seeding in this area are New Nortex and other Red Rustproof strains, Alamo and Mustang.

AREA 5

Oats are grown in area 5 primarily for winter pasture with the production of grain a minor consideration except for the preservation of seed supplies. Diseases are major factors in the production of grain almost every year and of forage in many years. Where irrigation water is available or fall and winter moisture conditions are favorable, as much as 7 months' grazing may be obtained from November to May. Experiments conducted on oats grown under irrigation show that as much as 10,000 pounds of air-dry forage per acre may be produced by oats during this period.

Yield trials of both spring-type tender varieties and winter-hardy varieties such as Mustang have been conducted at Beeville, Beaumont, Prairie View, Lockhart and College Station in this area. Comparable yields and agronomic data for area 5 are given in Table 9.

Alamo produced the highest average yields of grain and also the highest test weight during

TABLE 10. COMPARABLE YIELDS OF FALL-SOWN OATS GROWN IN NURSERY EXPERIMENTS AT DENTON AND COLLEGE STATION, 1947-56

Variety	Denton		College Station		
	Bushels per acre	Number years tested	Bushels per acre	Number years tested	Rank in yield
Bronco	51.8	6	50.5	6	13
Mustang	51.4	8	65.5	8	3
New Nortex	50.3	8	56.6	7	4
Nortex 107	49.1	7	52.8	5	12
Ferguson 922	48.8	8			
DeSoto	47.4	8	55.4	6	6
Cimarron	47.0	2			
Fulwin	45.5	8			
Victorgrain	44.3	8	66.4	8	2
Arkwin	44.2	5	42.4	1	17
Midsouth	40.1	2			
Alamo	40.1	7	66.8	8	1
Taggart	39.3	4	15.3	2	18
Fultex	38.5	8	53.5	7	8
Frazier	38.1	8	43.8	6	16
Delair	35.3	8	46.1	5	15
Southland	34.7	5	52.9	6	10
Sunland	34.3	2	53.3	4	9
Floriland	24.4	3	54.3	4	7
Seminole	14.1	2	46.4	3	14
Camellia			52.7	7	11
Alber			56.0	7	5

TABLE 11. YIELDS OF FALL VS. SPRING-SOWN NEW NORTEX OATS GROWN AT STATIONS IN TEXAS, 1936-58, FOR YEARS WHEN BOTH SEEDINGS MATURED A CROP

Location and years	Number years compared	Yield per acre, bushel	
		Fall sown	Spring sown
Denton, 1936-57	17	61.9	48.9
Temple, 1952-58	7	56.4	28.0
Iowa Park, 1952-58	7	80.8	30.7
Chillicothe, 1954-58	3	43.8	20.6
Amarillo, 1952-57	5	41.1	26.5

1950-57. Mustang, Victorgrain and Fulgrain also produced high yields because stem rust damaged them very little during this rather dry period. All these varieties are susceptible to race 216 of crown rust, which is now prevalent. Visual estimates of the forage value of these varieties indicated that Fulgrain, Alber, Alamo and Southland were best for forage purposes. The Florida varieties, Floriland and Sunland, are resistant to prevalent races of crown rust but very susceptible to stem rust.

AREA 6

No yields trials have been conducted in area 6. Oats are sown principally for forage uses in this sandy soil, high rainfall belt of Northeast Texas. New Nortex, Mustang and Bronco are the best adapted varieties for nearby area 3 and are suggested also for area 6.

AREA 7

No yield trials have been conducted in area 7. Oats are sown principally for winter pasture. Observations and experience by farmers indicate that Mustang, Bronco and New Nortex are satisfactory for this area.

NURSERY TESTS

Many experimental strains and commercial varieties are tested in replicated nursery yield trials at the main breeding station of College Station and Denton. These tests are separate from the Intra-state yield trials. There is considerable interest among growers and commercial seedmen in these varieties; therefore, data on yields are given in Table 10.

Data obtained in these tests are similar to those obtained in area trials. Bronco, Mustang and three Red Rustproof strains rank first to fifth in average yield at Denton. The commercial varieties Arkwin, Taggart and others were less productive than the recommended varieties. The Florida varieties Seminole, Floriland and Sunland were damaged by cold and ranked last. At College Station, Alamo, Victorgrain, Mustang, New Nortex and Alber ranked first to fifth, respectively, in average grain yield. Taggart, Arkwin, Frazier and Delair were lowest in yield as a result of rust damage.

Figure 12. Normal panicle of oats (left) contrasted with one destroyed by covered smut (center) and two (right) destroyed by loose smut.

Performance Trials of Spring-sown Oats

Thirty years ago more than half the oats grown in Texas were spring sown. In the principal oat growing sections of North Central Texas and the Rolling Plains, spring seedings are made during January and February. Most of the severe freezes occur in January and oats are seeded so the plants will emerge just after this

TABLE 12. COMPARABLE GRAIN YIELDS OF SPRING-SOWN OATS GROWN AT TEXAS STATIONS, 1952-57

Variety	Yield of grain, bushels per acre									Number of tests
	Amarillo 1952-57	Chillicothe 1952-57	Iowa Park 1952-57	Denton 1952-57	Greenville 1952-56	Temple 1953-56	McGregor 1953	Comfort 1953	State average	
Alamo	34.6	30.3	47.0	44.4	68.3	36.3	63.6	33.1	43.7	31
Frazier	27.8	29.2	44.6	41.7	60.1	29.7	44.8	38.0	39.2	31
Mustang	30.5	27.7	41.0	42.5	57.7	31.4	62.3	25.1	38.9	31
Fulgrain	36.9	29.7	41.7	40.5	57.7	29.5	61.8	25.7	38.8	20
Fultex	31.7	26.6	39.3	42.0	57.7	27.7	60.3	21.5	37.0	24
Bronco	24.9	18.5	33.6	37.4					29.9	6
New Nortex	28.1	17.0	30.5	37.2	36.3	26.0	45.1	6.1	29.1	31

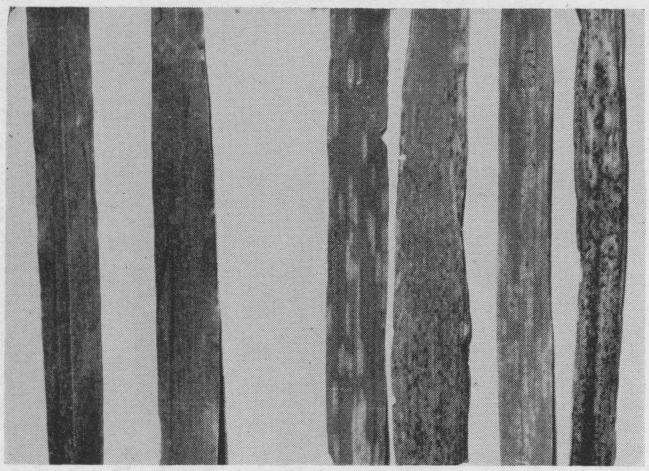

Figure 13. Normal leaves of oats (left) contrasted with leaves infected with crown rust (right).

period. Only a small percentage of the crop in this area is now spring sown except in years when widespread winterkilling of the fall-sown crop occurs.

Spring-sown oats mature later than fall-sown oats and may be injured more severely by hot weather and by diseases which develop on the fall crop and then spread to the later maturing spring crop. The New Nortex variety has been included in all performance tests, both fall and spring-sown, for many years. Table 11 gives average yields of New Nortex oats at five stations for years in which both fall and spring sown oats were harvested. Comparable yields of spring-sown oat varieties at several stations for 1952-57 are given in Table 12.

TABLE 13. COMPARABLE GRAIN YIELDS OF SPRING-SOWN OATS GROWN IN NURSERY PLOTS AT DENTON AND AMARILLO, 1949-57

Variety	Yield of grain, bushels per acre				
	Denton		Amarillo		
	Comparable average	Number tests	Comparable average	Number tests	Rank
Alamo	50.4	9	41.1	4	1
Mustang	50.4	9	37.8	3	3
Clintland	49.7	4			
Missouri 0-200	48.5	6	26.9	2	13
Bronco	48.2	8	36.2	2	5
Victorgrain	47.8	7			
Cimarron	47.6	2			
Missouri 0-205	46.9	2			
Andrew	46.9	8	27.7	2	12
Fultex	45.4	9	36.5	5	4
New Nortex	45.2	9	35.2	5	6
Frazier	44.3	9	33.7	4	8
Nortex 107	44.2	9			
Ferguson 922	43.5	9			
Cherokee	39.9	8	29.3	4	11
Nemaha	39.0	8	31.2	4	10
Fulwin	38.3	9			
Clinton	36.7	6	24.6	3	14
Shelby	34.2	2	23.8	2	15
Neosho			39.0	5	2
Osage			34.9	2	7
Bonda			31.4	2	9

Alamo has produced the highest yield of grain at nearly all stations and is outstanding when the average for the State is considered. The rapid seedling growth, early maturity and rust resistance of Alamo makes it well suited to spring seeding. Frazier ranks second and Mustang third in yield. Their early maturity, as compared with the Red Rustproof strains, probably gave them some advantage.

Table 13 presents the yields of Alamo and other Texas varieties when tested at Denton and Amarillo in comparison with the true spring-type oat varieties from major oat growing areas of the Midwest. Alamo ranked first at both locations. Mustang ranked second in most tests. Clintland and Missouri 0-200 yielded well at Denton while Neosho, Osage and Bonda were among the leading varieties at Amarillo. As there appears to be no advantage for these northern varieties, the local varieties Alamo and Mustang are recommended for spring seeding.

Diseases of Oats

The most common and destructive diseases of oats in Texas are the rusts, the smuts and Helminthosporium blights. Septoria diseases, powdery mildew, halo blight and diseases caused by species of Helminthosporium other than *victoriae* cause damage locally at times. Diseases may cause serious losses in yield and quality of grain, and they may also reduce the value of the crop for winter pasture. Detailed descriptions of the most important diseases attacking oats are available in Texas Agricultural Experiment Station Bulletin 921, "Diseases of Small Grains in Texas."

COVERED AND LOOSE SMUTS

The loose and covered smuts of oats are controlled by the same measures, therefore they will be treated together. Both types are found in Texas, but loose smut is more common. Loose smut destroys the entire panicle except for the central rachis, while the covered smut destroys the kernel but leaves the glumes more or less intact.

Oat smuts are caused by parasitic fungi, which enter the tissues of the seedling at time of germination and grow as mycelium within the plant tissues during the season, finally replacing the kernel or panicle with a mass of smut spores. These smut spores are spread to healthy kernels by the wind or in the threshing process. The smut spores remain on or within the hulls of the oat grain until germination time. Panicles of oats destroyed by loose and covered smuts in contrast to a normal panicle are shown in Figure 12.

Control of the oat smuts is easy and inexpensive. Most commercial seed cleaning establishments now have slurry or mist-spray type treaters to apply recommended fungicides. They may also be applied on the farm if proper equipment is available. Fungicide masks should always be worn when working with fungicides and the manufacturer's instructions should be followed closely. Treated seed is poisonous, and should not be fed to livestock. Proper treating of seed with a good fungicide will not only control smut but will improve germination by controlling other seedborne fungi.

CROWN RUST

The leaf rust of oats is called crown rust because of peculiar appendages on the teliospore, or black overwintering spore. Crown rust is the most destructive disease of oats in Texas and is a potential threat to the crop every year. Figure 13 shows the tiny rust spots or pustules of crown rust on an oat leaf.

Crown rust is caused by a fungus that enters the plant tissue through leaf stomata. The organism grows within the leaf tissue and reproduces in about 10 days. The round, orange pustules contain tiny spores which may be carried by wind currents to other plants or fields. The disease is favored by warm temperatures, heavy dews and frequent rain showers. The spores of the organism are carried into Texas from Mexico or may be carried southward by cold fronts in the fall. As conditions in South Texas are favorable for the disease during the winter, it persists during the winter and spreads northward as the season progresses.

The organism causing crown rust is made up of many races which may be likened to varieties of a crop plant. Some races can attack only a few oat varieties while others can attack many varieties. The prevalence of races changes with seasons and the varieties grown in an area of oat production. Alamo, Mustang, Ranger and several other varieties derived their crown rust resistance from Victoria and were highly resistant to races prevalent in Texas before 1957. Race 216, previously found in Florida and eastern states, became prevalent in Texas in 1957 and all Victoria-derived varieties were attacked by crown rust.

The only practical means of control of crown rust is growing resistant varieties. Recently several fungicides that will control rusts have been developed but their use is not yet practical. Varieties vary greatly in their reaction as well as in the degree of damage to grain production in the presence of the disease. The Red Rustproof strains are susceptible to prevalent races of crown rust yet frequently yield well in spite of considerable infection. Alber also has considerable tolerance to many races. Alamo, Ranger, Mustang and Victorgrain are resistant to many races but not to race 216. Suregrain, Moregrain, Floriland and Seminole are resistant to race 216 and many others but susceptible to race 264.

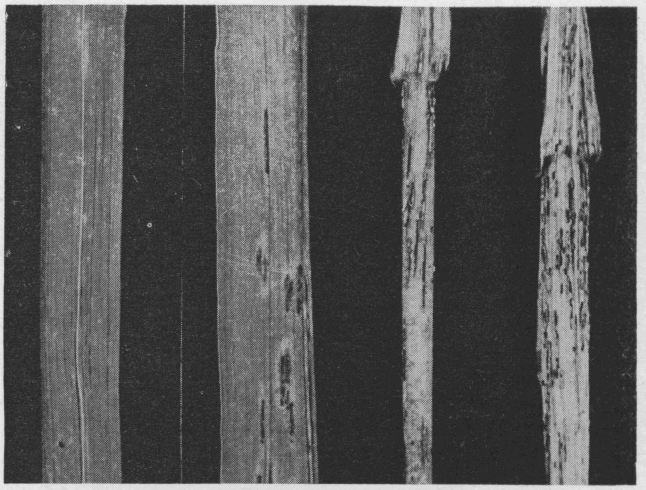

Figure 14. Normal leaf of oats (left) contrasted with leaf and stems infected with stem rust.

STEM RUST

The stem rust of oats also is a potential threat to the crop each season. This rust differs from crown rust in producing brick red, elongate, large pustules on the stems, leaf veins, leaves and even panicles of oats. As the crop matures, black spores are formed in these same pustules; hence the common name "black stem rust." When conditions are favorable, stem rust can develop rapidly and cause serious reductions in test weight and yield of oats. Stem rust is favored by temperatures from 75 to 85° F., frequent showers or heavy dews and high humidity. This disease, like crown rust, is carried into South Texas in the fall by cold fronts or it may move northward from Mexico where it is present throughout the year.

Growing resistant varieties is the only practical means of control of stem rust. Alamo is the only adapted variety with resistance to stem rust. This variety is resistant to many races of stem rust. All other Texas-grown varieties are susceptible to most races. Early maturing va-

Figure 15. Healthy plant of New Nortex oats (left) compared with plants of Fultex oats (right) showing varying degrees of damage by Helminthosporium blight.

TABLE 14. REACTION OF COMMERCIAL VARIETIES OF OATS GROWN IN TEXAS TO HELMINTHOSPORIUM BLIGHT

Resistant	Susceptible
New Nortex[1]	Fultex
Alber	Alamo
Camellia	Victorgrain
Midsouth	Fulgrain
Suregrain	Mustang[2]
Arkwin	Bronco[2]
Frazier	Traveler
Wintok	DeSoto
Fulwin	Ranger
Taggart	Rustler

[1]Includes other Red Rustproof strains.
[2]Considerable field tolerance under many conditions.

rieties such as Fulgrain, Frazier and Victorgrain may escape damage many years. Stem rust of oats is shown in Figure 14.

HELMINTHOSPORIUM BLIGHTS

Several blights attack oats in Texas. The most serious is that associated with varieties derived from the variety Victoria and commonly called Victoria blight. This disease is caused by a seedborne and soilborne fungus. Seedlings may be attacked as soon as the grain sprouts or at later stages. Killing of seedlings may result in poor stands, or surviving seedlings may be seriously stunted and produce only lightweight seed. Infected plants have reddish, pale leaves or this discoloration may involve only parts of the leaf causing stripes of discolored tissue. The roots are damaged and often rot so that the plant is poorly nourished. Stems become blackened as they mature, especially at the nodes, and they may lodge. Figure 15 shows a normal plant in contrast to others damaged by Helminthosporium blight.

Seed treatment with organic mercury fungicides will aid in controlling inoculum on the seed. Crop rotation will aid in reducing soil inoculum. The disease is favored by warm weather and high moisture conditions so it is most severe in South Texas and usually of little importance in areas 1 and 2.

Varieties differ greatly in reaction to Victoria blight. New Nortex and many others are highly resistant while Alamo, Fultex and others are very susceptible. Under field conditions Mustang and Bronco usually exhibit considerable tolerance to blight but they may be seriously damaged when conditions are very favorable for development of diseases. Table 14 gives the reaction of the most common varieties to Helminthosporium blight.

Insects

Oats may be attacked by a number of insects when conditions are favorable for the insect. Greenbugs and other aphids, the winter grain mite and other spider mites, grubworms, cut worms and armyworms all may damage the crop during the winter while it is in the seedling stage. Descriptions of these and other insects, with suggested means of control, are given in Texas Agricultural Experiment Station Bulletin 845, "Greenbugs and Some Other Pests of Small Grains."

Weeds

Fall-sown oats are usually free of serious weed infestations in Texas; however, if small grains are grown continuously on the same land, several winter annuals may give trouble. Recent importations of seed from California have been contaminated with wild oats, mustard and darnell seed. These weeds should be prevented from spreading. Johnsongrass is a problem in some wet seasons but usually the oats mature before this grass becomes troublesome. Most growers know how to handle sunflowers and other common annuals.

Figure 16. Wild oats growing along roadsides near Denton, 1953.

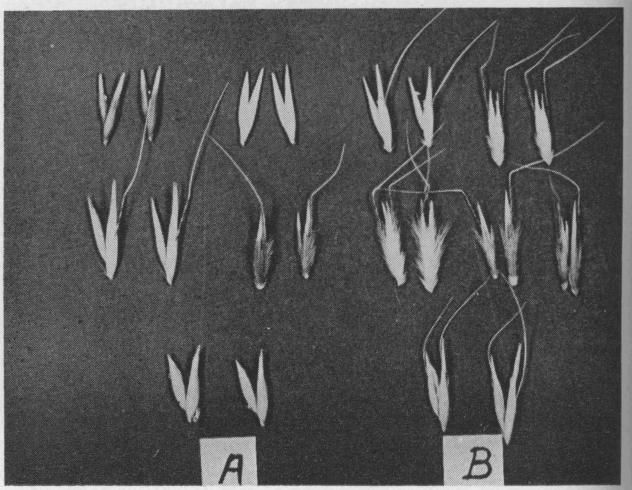

Figure 17. Cultivated Red Rustproof oats (B) in contrast to wild and false wild types (top rows) found as mixtures.

The most troublesome weeds in oats in Texas are wild oats, false wild oats and escaped cultivated types which grow along roadsides and fence rows. These not only spread into fields but serve as an early host for rusts and perhaps other diseases and provide food for aphids and spider mites, which then move to cultivated oats as soon as they are fall seeded. Crop rotation and destruction of this volunteer grain are urged for these reasons.

The wild and false wild oats shatter before the cultivated crop is harvested. This enables these types to increase rapidly. Furthermore, part of the seed from these plants may lie dormant for several years, part of the seed germinating each time the land is worked and the seeds are brought to a favorable seeding depth. Crop rotation and destruction of volunteer oats are necessary to keep wild oats in check. Thorough cleaning of planting seed will remove many of these wild types. Figure 16 shows wild oats growing along roadsides in North Central Texas; Figure 17 shows some of the wild and false wild types common in Texas.

Improvement of Oats

Research to improve oat varieties for growing in Texas was started in 1911 with the establishment of the Substation No. 6 at Denton, in the center of the oat producing area. Extensive selection in the Red Rustproof and Fulghum types of oats was carried on for many years. Yield trials of many varieties were started. The Nortex and Frazier varieties were distributed in 1926. A second strain of Red Rustproof, named New Nortex, was distributed in 1936.

Oat breeding to incorporate crown rust resistance from the variety Victoria started in 1930. The Ranger, Rustler and Fultex varieties developed from these crosses were released in 1942. After several years in which severe losses from winterkilling occurred, breeding for greater hardiness was emphasized and this resulted in the distribution of Mustang in 1951 and Bronco in 1956. The need for a better oat for South Texas was apparent and the variety Alamo was distributed in 1953. These varieties now occupy the majority of the acreage in Texas.

The breeding of new varieties is a long and expensive process usually requiring 10 to 15 years and the testing of thousands of strains to find the strain or strains that combine the good characters of the two parents. The floral parts of an oat spikelet are shown in Figure 18.

Crosses are made by transferring the pollen from one variety to the stigma of the flower of another variety. The hybrid populations must be grown and selected through four to eight generations before final selections are pure enough for performance trials in nursery plots. The selections must be tested for reaction to diseases by means of greenhouse or field tests. They are compared with parent varieties or good commercial varieties for yield, standing ability, resistance to shattering, forage production, test weight and other characters. They are first tested in single rows and later in replicated yield trials in comparison again with the best commercial varieties. Figure 19 shows the 1958 spring-sown oat nursery at Denton, where hundreds of strains are tested in nursery plots. A small harvester has been designed for cutting these plots and each harvested bundle is carefully covered with a paper bag to insure purity and save all seed. Figure 20 shows the field plots where strains are given final comparisons before release to farmers. Harvested fall-sown plots are shown in the foreground while later maturing spring-sown plots are in the background.

The breeding of oats for Texas conditions must include emphasis on characteristics that will make a variety suited to a certain growing area. For Northwest Texas this emphasis must

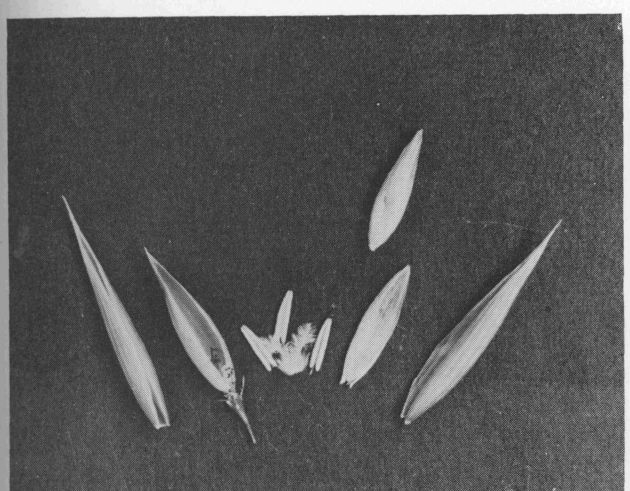

Figure 18. Floral parts of an oat spikelet. Crosses of oats are made by removing the anthers from the flowers and then fertilizing the flowers with pollen from the plant of another variety.

Figure 19. Spring-sown oat nursery at Denton, 1958. Small nursery plots of hundreds of strains are grown side by side for comparison under the same conditions. Note small harvester for nursery plots.

Figure 20. Fall-sown oat varieties (foreground) and spring-sown tests in field plots at the Denton station. Varieties are grown side by side for accurate comparisons of yield and other characteristics.

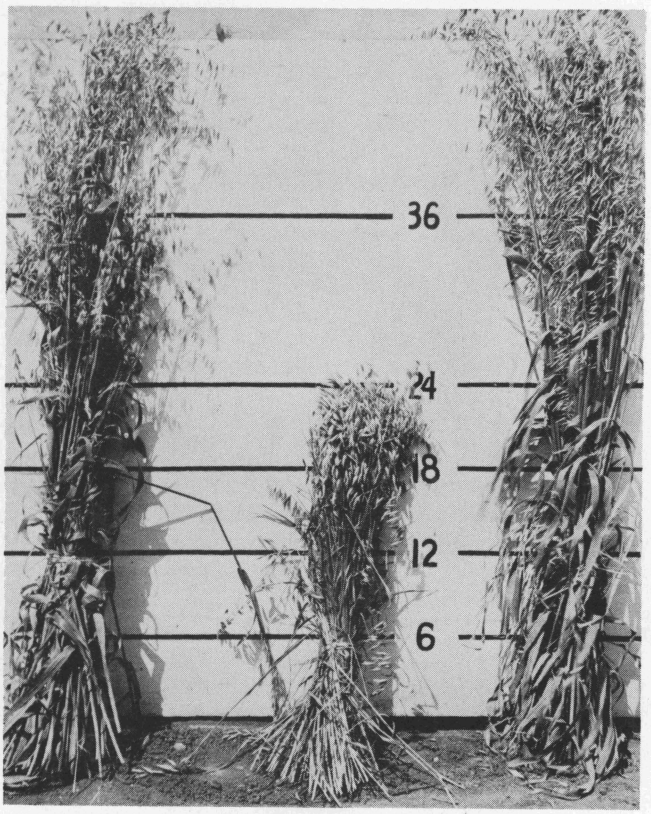

Figure 21. Normal height commercial oats (left and right) in contrast with short statue oats being developed for high rainfall, high fertility conditions.

be true winter hardiness; for North Central Texas this must be the ability to withstand wide fluctuations in temperature; for South Texas, disease resistance is a major consideration. Considerable emphasis has been placed on forage characteristics for different areas. Recently there is great interest in developing oats with better ability to stand for combine harvesting or for high fertility conditions so that yields may be raised to higher levels. Very short, strong-strawed varieties are being bred for this purpose. One of these strains in comparison with commercial varieties is shown in Figure 21.

While the development of new varieties and research to control diseases by means of sprays or to control insects by means of resistant varieties are slow and represent a major investment in funds, the improvement by any of these means is well worth the investment when projected to the three million acres of oats grown in Texas.

Acknowledgments

These investigations were conducted cooperatively by the Texas Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Acknowledgment is made of the cooperation of the many people and agencies taking part in these state-wide small grain variety tests: Lucas Reyes and Edward Neal, Substation No. 1 Beeville; Ralph Weihing and L. E. Crane, Substation No. 4, Beaumont; J. W. Collier and R. M. Smith, Substation No. 5, Temple; D. I. Dudley, Substation No. 6, Denton; Paul Marion and Wm. P. Hatchett, Substation No. 7, Spur; J. R. Quinby, Substation No. 12, Chillicothe; L. E. Brooks, Substation No. 16, Iowa Park; O. E. Smith, Substation No. 18, Prairie View; B. C. Langley, Substation No. 20, Stephenville; M. J. Norris and H. O. Hill, Substation No. 23, McGregor; Dow D. Porter, U. S. Cotton Field Station, Greenville; C. E. Van Doren, U. S. Southwestern Great Plains Field Station, Bushland; and M. C. Futrell and Owen Merkle, Main Station, College Station.

Off-station tests were conducted at Abilene in cooperation with F. M. Churchill and Keith Justice, Abilene Christian College; and at Floydada through the cooperation of Roy Hale and William Rogers.